TOWARD A CAPABILITY ENGINEERING PROCESS

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ABSTRACT

Defence R&D Canada is currently developing the Capability Engineering (CE) concept in order to close the gap between the Capability Based Planning (CBP) and the acquisition processes. This paper summarises results of initial investigations, which have created a good understanding of the problem, while raising many questions needing to be answered in developing a Capability Engineering Process (CEP).

1. INTRODUCTION

The Department of National Defence (DND), Canada, is implementing CBP as a core element in the overall business process. Currently, the CBP process leads to the acquisition of systems within that capability. The aim of the CE concept under investigation in the Collaborative Capability Definition, Engineering, and Management (CapDEM) Technology Demonstration Project (TDP), (Pagotto and Walker, 2004) is to create a systematic link between the conceptualization of a capability and the detailed definition of the component systems. The main outcome of CE is an improvement of decision-making for strategic investment. An analytical process or environment needs to be developed enabling trade-off analysis across systems to evaluate their overall impact on each other or on the overall capability. This process referred as the CEP should provide rigour and structure to enhance synchronization of capability transitioning.

The application of CE requires a process, supporting tools, and personnel with the skill sets to employ this process and tools. The best source for processes and tools at this time is the System Engineering (SysEng) domain, where the community has standardized processes and is actively using and enhancing tools in the area of requirements management, functional modelling, architecture modelling, use case definition, Computer Aided Design and Drafting (CADD), human form and behaviour modelling, life cycle cost modelling, and both constructive and virtual simulation. CapDEM's hypothesis is that these processes and tools, which are normally applied on a system level, can be extended to the capability level.

The CapDEM TDP has been established to define CE and to validate the discipline in the Canadian defence context, in collaboration with a wide range of DND and industrial community stakeholders. The article summarises results (CapDEM CEP Team, 2004) of the work conducted by the CapDEM CEP team from April 2003 to December 2003. The objective of this team, indeed for the whole CapDEM project, is to deliver a CEP that meets DND's needs. The development and evaluation of the CEP will be performed in three one-year cycles during the course of the project.

2. SOME OPTIONS

The CEP team has identified three key components for which characteristics need to be detailed before proceedings with CEP development: possible scopes, possible forms and possible solutions.

Investigations identified many possible methods to contribute to set up and improve capability generation in DND. The scope component of these investigations has identified different contexts of capability generation varying from "evolving in a few months a medium-size family-of-systems-based capability for a specific mission" to "creating, over a long period of time (e.g. 5-10 years), a dedicated System-of-Systems (SoS)". Within all these contexts of capability generation, it is possible to circumscribe an area and define a scope. Thus, this scope delimits the boundaries of the problem and its associated solution space.

A process form is defined as the specific characteristics of a process not directly related to its application. The number of deliverables and activities are examples of such characteristics that can be defined for most processes. The purpose of these characteristics is to serve as a guide throughout a process development. Making a choice in regard to these characteristics depends on resources available for the process development. In CapDEM TDP,

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many forms elements have been identified such as methodology, level of refinement, completeness, and level of adaptability to the organization. These forms elements will help to plan a process development strategy over a feasible schedule while allowing future extensions.

Finally, some candidate solutions have already been applied to solve similar problems and should be investigated to determine if they should be part of the solution: military acquisition, software engineering, SysEng, architecture description, etc.

3. SOME CHARACTERISTICS

Through its analysis, the CEP team has also identified some characteristics of the process: (1) elements, such as steps and deliverables, will need to be readily comprehensible and easily applicable; (2) the targeted process should minimize room for interpretations; (3) the process should allow re-use of models and data enabling leveraging between capabilities; and (4) the deliverables of the process must provide all the necessary information to support strategic investment decisions for DND capability implementation.

4. SOME QUESTIONS

During the literature review many questions were raised. Actually many of them brought us back to some of the options and characteristics expressed above. Here are the main ones: (1) should CE be able to construct virtual (short-term time frame) and/or dedicated (long-term time frame) capabilities?; (2) should CEP be concerned with self-evolution, joint evolution and emergent evolution (or any other types of evolution) of a capability?; (3) is CEP more relevant to solving managerial issues of concurrent engineering as opposed to traditional (but complex) SysEng issues?; (4) during which phases of the life cycle should CE be applied?; (5) what are the inputs and the outputs of CEP and who will use this information?; (6) should CEP be generic or tailored to its context of use?; (7) should CEP consider and propose a solution for all DOTMLPF[1] or PRICIE[2] aspects or be more selective like the US DoD 5000 acquisition strategies?; and (8) since a capability can be defined from business to technical level, which level(s) are optimal to define and to consider to reach the objectives of CEP? These questions are not easy to answer. A good knowledge of the requirements and the current situation ("as-is") is essential to provide a sound process. It will contribute to the identification of technologies that will form the CEP. It is even possible that the CEP itself will have a tailored methodology for each project, e.g. activities and notation may differ depending on the problem to solve.

CONCLUSION

The main CEP team results that are reported in this article concerns issues needing to be resolved to properly achieve the CEP team objective: delivering a CEP that meets DND's needs. From the literature review on subjects relevant to CE, the following two main conclusions were drawn: (1) the current Canadian situation regarding processes related to CE has to be mastered by the CEP team before drafting any solution; (2) the initial CapDEM definitions for "process" and "CE" has to be broadened.

Many questions remain to be answered before working out the CEP. Many of them will be answered when specific DND requirements, corresponding to the selected scope, are identified. Since the problem space of the CE is very large, an initial solution will likely tackle only a portion of the problem.

Based on the knowledge acquired during this first nine months, the next priority for the CEP team is to get a very good understanding of the current Canadian process. As a first step, the Canadian current situation, "as-is", will be studied, regarding mainly the current DND project approval process. In addition, other DND initiatives related to the CEP will be examined. In parallel, an international current situation assessment will be performed, looking at what is being done outside Canada. From the Canadian and international assessments and lessons learned from CapDEM case studies, CEP Version 1, will be elaborated.

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[1] DoD acronym for Doctrine, Organizations, Training, Materiel, Leadership, Personnel and Facilities,

[2] DND acronym for Personnel, R&D/Ops Research, Infrastructure & Organization, Concepts, Doctrine & Collective Training, IT Infrastructure, Equipment, Supplies and Services